VOL. 10, NO 22, DECEMBER, 2015 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

CORROSION BEHAVIOUR OF BORON CARBIDE REINFORCED ALUMINIUM METAL MATRIX COMPOSITE

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ABSTRACT

Cast aluminium A356 is most widely used in automobiles, marine and aircraft structures. The metal matrix composite was prepared by varying the weight percentage of reinforced boron carbide particle with A356 alloy by stir casting technique. The corrosion behavior of the composite was studied by salt spray test and the corrosion rate was evaluated by calculating the weight loss in the material. It is observed that A356-B_4C composite exhibited excellent corrosion when immersed in 5% NaCl solution. The SEM image of the composite also shows that the particle gets corroded surrounding the reinforced particle.

Keywords: corrosion, A356, stir casting, salt spray test, weight loss.

INTRODUCTION

Cast aluminium alloys are widely used to produce many complex parts, due to their good liquidity. Aluminium alloys exposed to the air are naturally protected by a layer of oxide film. However, this layer is heterogeneous and does not provide adequate corrosion protection in many environments. The anodizing technology is an effective method to improve the corrosion resistance of the aluminium and it has been universally applied. Pitting attack was reported to be the major form of corrosion in Al alloy/SiCp metal matrix composites. Cast Aluminium alloy MMCs reinforced with ceramic particulates like Sic, Al_2O_3, SiO_2,B_4C,TiO_2etc, By the addition of second phase into matrix material enhances not only physical and mechanical properties, but also changes the corrosion behaviour significantly.

Sun Huanhuan *et al.* studied the corrosion behaviour of A356 composite films in NaCl solution by electrochemical impedance spectroscopy He identified that the outer layer of the composite films had good protection effect at the initial stage of the immersion corrosion. When the corrosion time was increased, the aluminium matrix was not corroded. Thus, the higher protection degree of the composite films for A356 aluminium alloy was attributed to the synergism effects of anodic film and rare earth Ce film [1].

The corrosion behaviour of 6061 Al alloy with SiC particles composite at four different temperatures (30°, 40°, 50° and 60°C) in hydrochloric acid medium (0.5 and 1 M) using Tafel extrapolation technique and weight loss method. The adsorption of the inhibitor on the composite surface is found to obey Temkins and Langmuir adsorption isotherms. The inhibition is governed by physisorption mechanism [2]. Mamatha. G. P investigated the corrosion behaviour of aluminium 7075 with SiC particle in HCL medium. Corrosion tests were conducted by weight loss method for different exposure time where 1N HCl was used as corrodent. The corrosion rate of MMCs was lower than that of matrix Al 7075 alloy under the corrosive atmosphere [3]. By means of gravimetric and electrochemical measurement A356 gives more resistance to pitting corrosion [4]. In aluminium reinforced bamboo leaf ash composite corrosion behaviour was studied by weight loss method. The specimen was immersed in H_2SO_4 and 5% NaCl solution and the corrosion rate was evaluated [5]. Al 7075 reinforced with zircon was immersed in natural seawater and autoclave method is employed to find the corrosion behaviour. The presence of hydrogen in the composites increases the corrosion rate. By increasing the reinforcement percentage in the composite the corrosion was decreased [6]. The corrosion behaviour of aluminium 6061 with silica particle was studied and it shows that there are some micros cracks are developed in the composites and some pits are observed due to particle dislocation [7].

From the above investigation it is intended to evaluate the corrosion resistance of boron carbide reinforced aluminium matrix composite in 5% NaCl solution which has a typical application in automobile brakes.

2. MATERIALS AND METHOD

2.1 Material

The material used in this study is Aluminium 356 alloy, having the chemical composition as shown in Table-1. Boron Carbide (B_4C) particle of size 104 micron was used as the reinforcing material.

Table-1. Chemical composition of A356 alloy.

Si	Fe	Cu	Mn	Mg	Ni	Zn	Ti	Al
6.58	0.16	0.06	0.06	0.57	0.01	0.01	0.14	balance

2.2 Fabrication of composite

The Aluminium alloy (A 356) was fed into an electric furnace and heated upto 650º .The metal was stirred with the help of mechanical stirrer to form a fine vortex .The boron carbide powder (104 micron) along with K_2TiF_6 flux is preheated at about 340ºC and it is added with the molten metal. The molten mixture is then stirred continuously at 320 rev/min. The molten liquid metal is poured into the permanent mould which has preheated at 300ºC. By varying the weight percentage of the boron carbide (3%, 6%, 9%, 12%) the material has been fabricated.

2.3 Salt spray test

The corrosion tests was carried out in 5 % NaCl mixed with 95% of distilled water The specimen of size 20mm X20mmX 6mm were cut as per ASTM B117M standard and it was polished by 1200 grit size emery sheets. Then the specimen is polished smoothly in the polishing machine using diamond paste. The cut samples were degreased with acetone and then rinsed in distilled water before it gets immersed in the solution. The specimen is then tied in a nylon wire and immersed in the salt spray chamber and it should be closed. The salt water is sprayed continuously for 48hrs and the fog developed inside the chamber. The NaCl reacts with aluminium metal and the white rust forms on the surface. The results were evaluated by weight loss and the corrosion rate was measured by immersing the specimen in an interval of 2 days. Figure-1 shows the salt spray chamber in which the specimens were immersed.

Figure-1. Salt spray chamber.

3. RESULTS AND DISCUSSIONS

Figure-2 and Figure-3 shows the weight loss and the corrosion rate of the composite. From Figure-2 it clearly indicates the weight loss increases as the reinforcement increases. The carbon particle in the boron carbide reacts with the NaCl solution and forms rust surrounding the particle. It is due to the presence of small amount of iron present in the aluminium matrix alloy. Since boron carbide is highly resistance to corrosion, the corrosion rate is more when compared to other reinforcing particle.

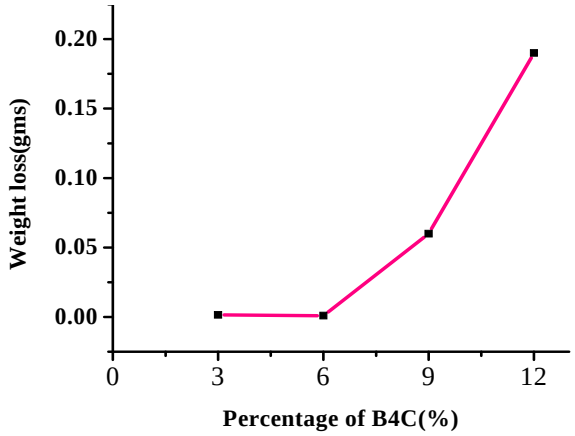


Figure-2. Weight loss of the composite.

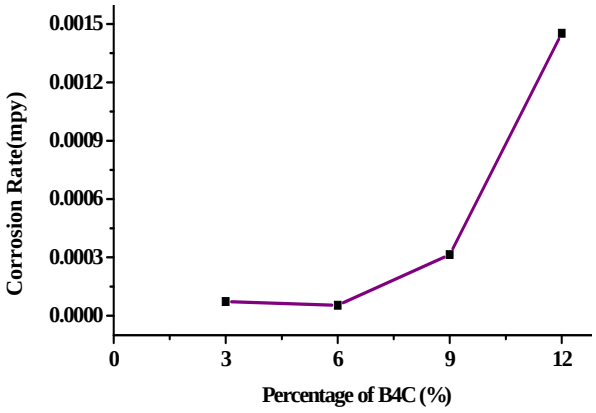
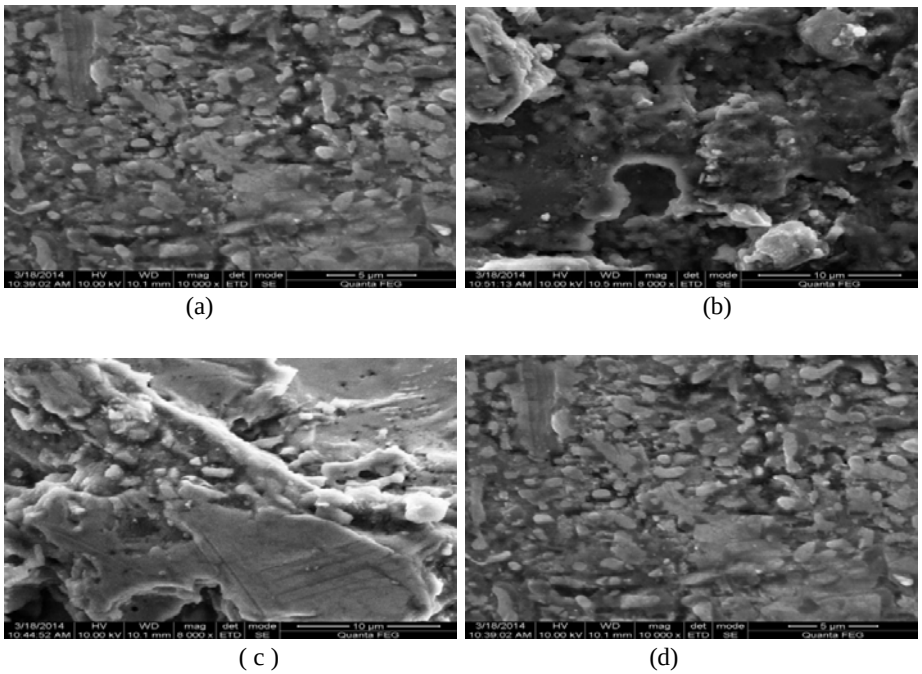


Figure-3. Corrosion rate of the composite.

SEM structure

The Figure-4 shows the SEM images of corroded structures. Figure-4(b) clearly shows that the boron carbide particle was corroded and it tends to get peal of from the matrix. It also identified that the particle gets corroded on its surroundings. From Figure 4(a) and 4(c) it is seen evidently the material get acts on the sodium

chloride solution and tends to remove. Further if the immersion time has been increased the reinforcing material may removed completely by the action of NaCl solution.



(a) (b)

(c) (d)

Figure-4. SEM structure of corroded composite (a) 3% (b) 6% (c) 9% (d) 12%.

4. CONCLUSIONS

Corrosion behaviour of aluminium 356 reinforced with aluminium composite was fabricated by stir casting process and its corrosion behaviour was studied using salt spray test. It was observed from the results that the composite has good corrosion resistance in sodium chloride medium.

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